In the specification:

Please amend the paragraph beginning at page 8, line 2 as follows:

FIG. 1 shows one embodiment 100 of a direct electrical-to-optical conversion system based on a micro whispering-gallery-mode resonator 101 formed of a dielectric material with appropriate energy levels. In one implementation, the micro resonator 101 generally may be formed from at least a portion of a whole dielectric sphere that includes the equator of the sphere. Such a resonator can support a special set of resonator modes known as "whispering gallery modes" which are essentially electromagnetic field modes confined in an interior region close to the surface of the sphere around its equator and circulating by total internal reflection inside the axially symmetric dielectric body. Microspheres with diameters on the order of $10\sim10^2$ microns have been used to form compact optical resonators. Such resonators have a resonator dimension much larger than the wavelength of light so that the optical loss due to the finite curvature of the resonators can be small. The primary sources for optical loss include optical absorption in the dielectric material and optical scattering due to the inhomogeneity of the sphere (e.g., irregularities on the sphere surface). As a result, a high quality factor, Q, may be achieved in such resonators. Some microspheres with sub-millimeter dimensions have been demonstrated to exhibit very high quality factors for

light waves, exceeding ~~109~~ 10^9 for quartz microspheres. Hence, optical energy, once coupled into a whispering gallery mode, can circulate at or near the sphere equator with a long photon life time. The resonator 101 may be the whole sphere or a portion of the sphere near the equator that is sufficiently large to support the whispering gallery modes such as rings, disks and other geometries.

Please amend the paragraph beginning at page 13, line 12 as follows:

Notably, the dielectric material for the micro resonator 101 is specially designed or selected to have an energy structure shown in FIG. 8 for interacting with both the input electrical signal 132 and the input optical signal 114. The energy structure has three energy levels 801a, 801b, and 801c where 801a and 801c are two different ground states and the level 801b is an exited state. Optical transitions are permissible from both ground states 801a and 801c to the excited state 801b. For example, upon absorbing a~~n~~ photon from the input optical signal 114 in resonance with the transition 810 from the ground state 801a to the excited state 801b, an electron is excited from the ground state 801a to the excited state 801b. This electron on the excited state 801b, in turn, can emit an photon and thus decay to either of the ground states

801a and 801c, generally with different ~~delay~~ decay rates. Arrowed lines 820 and 830 represent such radiative ~~delay~~ decay processes. The two ground states have an energy difference 840 that corresponds to a frequency in the electrical domain, e.g., the RF, microwave, and millimeter spectral ranges. In addition, the relaxation or decay rate from the upper ground state 801a to the lower ground state 801c is small and is practically negligible in comparison with the ~~delay~~ decay rates from the excited state 801b to either ground state.

Please amend the paragraph beginning at page 16, line 23 as follows:

As described above, in absence of the electrical signal 132, the optical transition 810 between the ground state 801a and the excited state 801b transfers all electron population initially in the ground state 801a to the other ground state 801c which no longer interact with the optical signal ~~132~~114. If the electrical signal 132 ~~is~~ at a frequency in resonance with the energy gap is applied 840, the ~~photons~~ energy in the electrical signal 132 ~~are~~ is absorbed by the electrons trapped in the ground state 801c to jump to the depleted ground state 801a. This process in effect makes the electrons available again for absorbing energy in the optical signal ~~132~~ 114 in the ~~under~~ transition 810 to artificially overcome the lack of

sufficient relaxation between the ground states 801a and 801c. In addition, the quality factor Q of the resonator 101 is significantly reduced due to the increase of the optical loss upon application of the signal 132 in resonance with the gap 840. Therefore, in the presence of such a signal 132, the dielectric material becomes at least partially opaque to the optical signal 114. The degree of this opaqueness of the dielectric material depends on the characteristics of the signal 132, such as the deviation of the frequency of the signal 132 from the resonance frequency of the energy gap 840, the amplitude of the signal 132, or both the frequency deviation and the amplitude. This dependence can be used to directly convert a modulation in the electrical signal 132 to the optical signal in the resonator 101 or the output optical signal 116.

Please amend the paragraph beginning at page 18, line 18 as follows:

In practice, ~~the~~ a microwave field or signal at 11.5 GHz may be coupled to fill the entire resonator. This can be advantageous because the optical field in the whispering gallery mode, confined to a small mode volume of less than about 30-micron radial extent near the equator surface, partially overlaps with the microwave field. This partial overlap allows for the use of ruby with normal concentrations of chromium ions

to reduce the effect of relaxation between the hyperfine ground states. The rate of this relaxation is ordinarily high so that absorption may be observed at a temperature of about 77 K or below. The Cr^{3+} concentration should be small so that the relaxation process does not mask the absorption of the applied microwave field. The signal generated through relaxation (i.e., noise) should be smaller than the applied microwave power (signal). At the room temperature, the relaxation rate between the two ground states $^4A_2(1/2)$ and $^4A_2(3/2)$ is about 10^7 per second. Hence, for a ruby sphere of 2.5 mm and doped with chromium at 1.2×10^{18} per cubic centimeter, the microwave power for this relaxation rate is about 0.1 microwatts. This noise is about a factor of 10 less than the goal of detecting a signal of one microwatt. Thus, the partial and incomplete overlap between the optical mode and a portion of the microwave field volume in fact can facilitate the detectability of this signal level above the noise. The above estimate is approximate in that the loss in coupling the microwave power to the resonator is not included.

Please amend the paragraph beginning at page 20, line 14 as follows:

Hence, the present scheme works based on the direct absorption of the electrical signal 132 by the electrons in the

dielectric material. This process directly changes the electron population available for participating the optical transition in resonance with the input optical signal 114 coupled into the whispering gallery mode of the resonator 101. In this context, the electrical to optical conversion is direct and can be highly efficient to ~~allow for~~achieve single microwave photon detection of an electrical signal or sensitive and efficient electrical-to-optical conversion.

Please amend the paragraph beginning at page 22, line 1 as follows:

It is further contemplated that, the above direct electrical-to-optical conversion mechanism may be combined with electro-optic modulation techniques. In addition to the energy structure shown in FIG. 8, the dielectric material of the resonator 101 may also be designed to exhibit the electro-optic effect so that its refractive index changes with an applied electrical field. U.S. Patent No. 6,473,218 issued on October 29, 2002 from U.S. Application No. 09/591,866 filed on June 12, 2000 by Maleki et al., for example, describes electro-optic modulators based on micro whispering gallery mode resonators. This combination can be used to form novel modulators.